SURGICAL ANTIBIOTIC PROPHYLAXIS

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OBJECTIVES

• Discuss antibiotic use as prophylaxis vs presumptive therapy vs treatment of infections.

• Discuss risk factors for developing a surgical wound infection.
  – NRC wound classification and risk of infection

• Discuss selection and administration of antibiotic therapy for surgical procedures.

• Discuss duration of antibiotic therapy for prophylaxis
INTRODUCTION

• Approximately 23 million surgical procedures are performed per year in the United States.
• Post operative infection rate = 6%
• > 1 million surgical wound infections per year
• 25% of all nosocomial infections are related to surgical wound infections
  – Several of these infections are probably preventable
INTRODUCTION

• Surgical wound infections increase health care costs by about 1.5 billion/year
  – Prolonged hospitalization stay
  – Increased morbidity/mortality

• Prophylactic antibiotics have been shown to decrease the risk of infection for many procedures and represents an important component of optimal management of the surgical patient.
  – Surgical antibiotic prophylaxis is well established and common practice.
INTRODUCTION

• Controversies regarding prophylactic antibiotic use include:
  – Selection of antibiotic therapy
  – Duration of antibiotic therapy
  – Development of bacterial resistance
  – Role of newly developed antibiotics

• Factors resulting in failure of prophylaxis
  – Inadequate timing of antibiotic
  – Failure to readminister antibiotic for prolonged procedures
DEFINITIONS

• **Prophylaxis:**
  – Administration of an antibiotic prior to contamination of previously sterile tissues or fluids.

• **Presumptive therapy:**
  – Administration of an antibiotic when there is a strong possibility but unproven established infection

• **Treatment:**
  – Administration of an antibiotic when an established infection has been identified.
DEFINITIONS

• Surgical wound infections (SWI):
  – Incisional infections identified by purulent or culture positive drainage is isolated from any structure above the fascia in proximity to the initial wound
  – Deep infections are characterized by purulent drainage from subfascial drains, wound dehiscence, or abscess formation and involve adjacent sites manipulated during surgery.
  – Wound Dehiscence
  – Breakdown of the surgical wound
WOUND CLASSIFICATION

- Identifying patient risk
  - Even with adequate sterile techniques and potent antibiotics wound infections develop in 2-9% of all surgical procedures
  - Bacteria are found in 90% of surgical incisions despite all aseptic precautions.
  - The National Research Council stratifies infection risk by surgical procedure
    - Clean
    - Clean/contaminated
    - Contaminated
    - Dirty
WOUND CLASSIFICATION

• Clean
  – SWI risk (<2%)
  – Elective surgery
  – No acute inflammation or transection of gastrointestinal (GI) tract, oropharyngeal, genitourinary (GU), biliary or tracheobronchial tracts
  – No break in aseptic technique
  – Examples include:
    - Craniotomy, orthopedic surgery, cardiothoracic and vascular surgery
  – Antibiotic use is controversial
WOUND CLASSIFICATION

- Clean-contaminated
  - SWI risk (2-10%)
  - Urgent or emergent case that is otherwise clean, controlled opening of GI, GU, oropharyngeal, biliary, or tracheobronchial tracts,
  - Minimal spillage and/or minor aseptic technique break
  - Examples include:
    - Invasive head and neck surgery, cholecystectomy, urologic procedure, hysterectomy, orthopedic surgery with prosthesis
    - Antibiotics used for prophylaxis
WOUND CLASSIFICATION

• Contaminated
  – SWI risk (10-20%)
  – Any procedure in which there is gross soiling of the operative field during procedure, as well as surgery of open traumatic wounds (< 4 hours old).
  – Examples include:
    - Colorectal surgery with spillage, biliary or GU tract surgery in the presence of infected bile or urine and clean or clean/contaminated procedures marred by a major break in technique.
    - Antibiotics used for prophylaxis
WOUND CLASSIFICATION

- Dirty
  - SWI risk (>30%)
  - Purulence or abscess, preoperative perforation of GI, oropharyngeal, biliary, or tracheobronchial tracts, penetrating trauma > 4 hours old.
  - Examples include:
    - Perforated appendicitis with abscess formation
  - Antibiotics are utilized for treatment and not prophylaxis
IDENTIFIED RISK FACTORS

- Incidence of a SWI depends on numerous factors specific to either the procedure itself or the individual patient.
  - Type of surgical procedure and bacterial load encountered
  - Underlying medical condition of the patient
  - Surgical procedure
    - Technique
    - Duration
    - Patient preparation
    - Equipment preparation
RISK FACTORS

• Patient-related factors
  – Age > 60, sex (female), weight (obesity)
  – Presence of remote infections
  – Underlying disease states
    - Diabetes, congestive heart failure (CHF), liver disease, renal failure
  – Duration of preoperative stay
    - hospitalization > 72 hours, ICU stay
  – Immunosuppression
  – ASA (American Society of Anesthesiologists) physical status (3,4, or 5)
# ASA Risk Factors

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal healthy patient</td>
</tr>
<tr>
<td>2</td>
<td>Mild systemic disease</td>
</tr>
<tr>
<td>3</td>
<td>Severe systemic disease not incapacitating</td>
</tr>
<tr>
<td>4</td>
<td>Incapacitating systemic disease that is a constant threat to life</td>
</tr>
<tr>
<td>5</td>
<td>Not expected to survive 24 hrs with/without operation</td>
</tr>
</tbody>
</table>
RISK FACTORS

• Surgery-related factors
  – Type of procedure, site of surgery, emergent surgery
  – Duration of surgery (>60-120 min)
  – Previous surgery
  – Timing of antibiotic administration
  – Placement of foreign body
    - Hip/knee replacement, heart valve insertion, shunt insertion
  – Hypotension, hypoxia, dehydration, hypothermia
RISK FACTORS

• Surgery related factors
  – Patient preparation
    - Shaving the operating site
    - Preparation of operating site
    - Draping the patient
  – Surgeon preparation
    - Handwashing
    - Skin antiseptics
    - Gloving
RISK FACTORS

- Wound-related factors
  - Magnitude of tissue trauma and devitalization
  - Blood loss, hematoma
  - Wound classification
    - Potential bacterial contamination
  - Presence of drains, packs, drapes
  - Ischemia
  - Wound leakage
## ANTIBIOTICS USE

<table>
<thead>
<tr>
<th>Procedure</th>
<th>NNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Heart Surgery</td>
<td>14</td>
</tr>
<tr>
<td>Colorectal Surgery</td>
<td>5</td>
</tr>
<tr>
<td>Head &amp; Neck-Clean</td>
<td>NA</td>
</tr>
<tr>
<td>Head &amp; Neck-Contaminated</td>
<td>3</td>
</tr>
<tr>
<td>Total Hip replacement</td>
<td>42</td>
</tr>
<tr>
<td>Hip Fracture Repair</td>
<td>58</td>
</tr>
</tbody>
</table>
ANTIBIOTIC SELECTION

• Characteristics of an optimal antibiotic for surgical prophylaxis
  – Effective against suspected pathogens
  – Does not induce bacterial resistance
  – Effective tissue penetration
  – Minimal toxicity
  – Minimal side effects
  – Long half-life
  – Cost effective
ANTIBIOTIC USE

• Appropriate antibiotic use for prevention of SWI includes the following:
  – Appropriate timing of administered agents and repeated dosing based on length of procedure and antibiotic half-life
    - Consider redosing if procedure > 4 hours
  – Appropriate selection based on procedure performed
  – Appropriate duration to avoid infection and decrease potential for development of resistance
ANTIBIOTIC USE

• Antibiotic selection
  – Must be effective against organisms most likely to be encountered
    - Endogenous organisms related to type of surgical procedure performed
    - Exogenous organisms introduced secondary to poor surgical technique
  – Must provide adequate tissue penetration for effective concentrations
  – Avoid using broad spectrum agents when unnecessary
    - Widespread use facilitates development of resistance
    - 3rd generation cephalosporins have no role in prophylaxis
ANTIBIOTIC SELECTION

- **Nose**
  - S. aureus, pneumococcus, meningococcus
- **Skin**
  - S. aureus, S. epidermidis
- **Mouth/pharynx**
  - streptococci, pneumococcus, e.coli, bacteroides, fusobacterium, peptostreptococcus
- **Urinary tract**
  - E.coli, proteus, klebsiella, enterobacter
ANTIBIOTIC SELECTION

- Colon
  - E. coli, klebsiella, enterobacter, bacteroides spp, peptostreptococci, clostridia
- Biliary tract
  - E. coli, klebsiella, proteus, clostridia
- Vagina
  - Streptococci, staphylococci, E. coli, peptostreptococci, bacteroides spp.
- Upper respiratory tract
  - Pneumococcus, H. influenzae
ANTIBIOTIC SELECTION

- Cefazolin is the most common agent utilized when skin flora is the source of contamination
  - All clean procedures
    - Cardiothoracic surgeries
    - Neurosurgical procedures
    - Orthopedic surgery
    - Vascular surgery
  - Several clean/contaminated procedures
    - Controlled opening of GI tract
    - Head and neck surgery
ANTIBIOTIC SELECTION

• Vancomycin
  – Utilized as prophylaxis in institutions in which methicillin resistant S. aureus and S. epidermidis are a frequent cause of postoperative wound infection
  – Utilized in patients with documented allergies to Penicillins and cephalosporins
  – Increased empiric use likely contributes to the development of vancomycin resistant enterococcus (VRE)
Surgical procedures which enter the gastrointestinal, oropharyngeal, genitourinary, biliary, or tracheobronchial tracts and result in spillage of bacteria require increased gram negative and anaerobic coverage.

- Cefoxitin or cefotetan alone
- Clindamycin with aminoglycoside
- Metronidazole with cefazolin
- Broad spectrum agents are frequently utilized for prophylaxis as monotherapy
  - Unasyn, Timentin, Zosyn, Primaxin, Merrem
ANTIBIOTIC SELECTION

• Dirty procedures
  – Patient already has an established infection and requires a surgical procedure that is often times emergent.
  – Therapeutic course of antibiotics is required and is no longer considered prophylaxis
  – Ruptured appendix
    - Significant bacterial spillage results with an established intra-abdominal infection
    - Surgery required to remove remains of appendix
  – Requires broad spectrum activity
    - Unasyn, Timentin, Zosyn, Merrem, Primaxin
ANTIBIOTIC SELECTION

- Bacterial counts in the gastrointestinal tract vary depending on location
  - Esophagus and stomach
    - Normally <1000 organism/ml
  - Duodenum and jejunum
    - 100-10,000 organisms/ml
  - Ileum
    - 1-10 million organisms/ml
  - Colon
    - 2/3 dry fecal matter is bacteria (400-500 different species)
ANTIBIOTIC USE

- Oral prophylactic regimen to decrease bacterial colonization for elective colo-rectal surgery.
  - Mechanical bowel preparation
    - Use of Go-Lytely
  - Oral antibiotics
    - Erythromycin base and neomycin 1gm PO @ 1pm, 2pm and 11pm (for an 8 am surgery or 19, 18 and 9 hours preop)
  - This regimen in addition to IV antibiotics (cefoxitin or cefotetan) further reduces risk of post-operative infection
ANTIBIOTIC USE

• Timing of antibiotic administration
  – It is clear that antimicrobial prophylaxis is effective when administered prior to the first incision.
    - Antibiotic must be present in adequate concentrations in the tissues when bacterial contamination occurs.
    - Administration within 30-60 minutes of incision
  – Adequate antibiotic concentrations must be maintained throughout the surgical procedure
    - Dependent upon the length of surgery and antibiotic half-life
    - Redose antibiotic if surgical procedure exceeds 2 half-lives of drug utilized
ANTIBIOTIC USE

• Antibiotic duration
  – Few good clinical trials support the current guidelines related to the duration of prophylaxis
  – The duration of antibiotics should not exceed 48 hours
  – Clean surgery procedures, a single dose is generally appropriate
  – For clean-contaminated and contaminated procedures 24 hours duration is most commonly utilized and recommended
• Patients with underlying structural cardiac defects are at risk for developing endocarditis and antibiotic prophylaxis is recommended when bacteremia may occur during specific procedures
  – Presence of prosthetic cardiac valves
  – Previous bacterial endocarditis
  – Congenital cardiac malformations
  – Acquired valvular dysfunction (Rheumatic heart disease)
  – Mitral valve prolapse with regurgitation
ENDOCARDITIS PROPHYLAXIS

- Procedures resulting in bacteremia increasing at risk patients for development of endocarditis
  - Dental and oral procedures
    - procedures likely to result in bleeding
    - Oral antibiotic regimens recommended
      - Amoxicillin 2 gm 1 hr before procedure, children = 50mg/kg
      - PCN allergic Clindamycin 600 mg (children 20 mg/kg), cephalaxin 2 gm (children 50 mg/kg), or azithromycin/clarithromycin 500 mg (children 15 mg/kg) 1 hr before procedure
  - Respiratory, GI and/or GU tract procedures

JAMA 1997:277:1794-1801
SUMMARY

• Surgical prophylaxis can significantly reduce the incidence of post-operative wound infections
• Several appropriate antibiotics available for use
  – Cefazolin remains the most common agent used for prophylaxis
SUMMARY

- Identify wound infection risk based on patient’s surgical procedure
  - Clean
    - Cefazolin
  - Clean/contaminated
    - Cefazolin vs broad spectrum (cefoxitin or cefotetan)
  - Contaminated
    - Broad spectrum (cefoxitin or cefotetan)
  - Dirty
    - Therapeutic antibiotics
SUMMARY

• Several risk factors contribute to wound infection
  – Patient related factors
  – Surgery related factors
  – Wound related factors

• Antibiotic use
  – Effective against suspected pathogens
  – Effective tissue penetration
  – Minimal toxicity
SUMMARY

• Appropriate timing of administered antibiotics
  – Must be given 30-60 minutes before incision
  – Repeat dose if procedure is longer than two half-lives of antibiotic utilized
    - Rule of thumb = 4 hours

• Duration of use
  – Controversial
  – Does not need to be > 48 hours
  – 1 preop does utilized for clean procedures
  – 24 hours duration following procedure is most commonly utilized